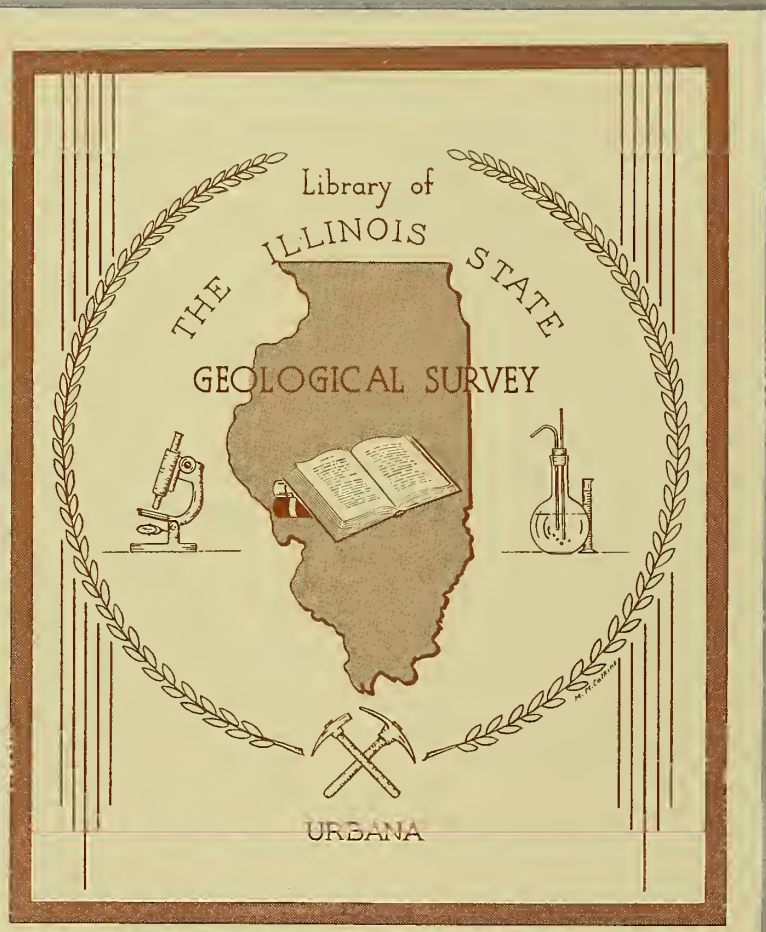

Illinois State Geological Survey
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Information Circular

EFFECTS OF WATER FLOODING ON OIL PRODUCTION FROM THE McCLOSKY SAND, DENNISON TOWNSHIP, LAWRENCE COUNTY

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Introduction

The normal decline in the production of oil wells over a period of years is due to the release of natural pressure in the oil sand resulting from the escape of gas and fluids. Some form of artificial repressuring eventually becomes necessary if profitable production is to continue. This stage has already been reached in the Illinois fields, many of which have been producing oil for more than twenty years at a gradually declining rate. At present their average daily production is less than one barrel per well.

In connection with a general study of possible methods of repressuring by means of natural gas, air, or water, the attention of the Illinois State Geological Survey has been called to an area in the north part of Dennison Township, Lawrence County, in which increased oil production from the McClosky sand has resulted from accidental water flooding. The results of a study of subsurface conditions, which was undertaken by the Survey at the request of some of the producers, suggest that the source of the flood water may be another rock stratum, either above or below the McClosky sand. This report is presented primarily as a summary of available data; it is planned to publish a detailed report, including maps, at a later date.

Production of oil from the McClosky sand began in sec. 25, T. 3 N., R. 13 W., Dennison Township, Lawrence County, in 1909 and within five years wells drilled into edge water had outlined the area of productive McClosky sand. The total area of McClosky sand production in southern Lawrence County is approximately five square miles, and consists of several pools which may or may not be interconnected by porous sand. At present the flooded area in the McClosky sand extends about 3 miles in a northeast-southwest direction and includes approximately 2 square miles.

The axis of the main anticlinal structure on which this field is located trends slightly west of north and east of south, passing through the west half of sec. 35, T. 3 N., R. 13 W. The westward dip is about 80 feet per mile and the eastward 40 feet per mile; the southerly plunge is variable, averaging 50 feet per mile from the north edge of sec. 35 to the south edge of sec. 2*

Water Flooding

Evidence. In certain wells in the area of productive McClosky sand there have occurred large increases in oil production followed shortly by rapid increases in the water-oil ratio, usually to such an extent that it has been necessary to plug back the wells to one of the higher sands. This sequence of events in numerous wells forms a definite proof that oil has been forced ahead of water.

Variations in rate of advance. The rate of advance of the flood, which has varied widely in different directions, has been controlled largely by the thickness and "openness" of the sand. No direct data on the "openness" of the sand are available but comparison of sand thicknesses with the positions of

*Blatchley, R. S., The Crawford and Lawrence County oil field; Illinois State Geol. Survey Bull. 22, Pl. 9 (pocket), 1913; (A structure contour map of the Kirkwood sand.) This bulletin is obtainable from the State Geological Survey, price $1.75.

the flood front at five-year intervals indicates that the flood advanced most rapidly in areas where the sand is generally thickest. A larger increase in rate of oil production may reasonably be expected from water flooding when there is a relatively rapid advance of the flood.

Relation to areas of high initial production. The same factors which control the rate of advance of the flood also controlled the initial production of the McClosky sand wells. It was found that wells which had initial productions of more than 1500 barrels are grouped into three districts centering around (a) NW. 1/4 SE. 1/4 sec. 25 in the Miller McCroskey lease, (b) NE. 1/4 NE. 1/4 sec. 25 in the George Ryan lease, and (c) SW. 1/4 SE. 1/4 sec. 35 in the L. Jenner lease. In these areas of high initial production the sand thickness is above the average for the district.

One condition for high initial production, namely a sand which is thicker and more open than average, also permits a relatively rapid advance of the flood. Therefore in districts where conditions permit increased production due to flooding, relatively large increases may be expected from wells which had a high initial rate of production.

Advance shown by production records. Production from an oil well normally has a definite rate of decline. An extraneous condition such as the advance of flood water is reflected by a rise in the normal production decline curve. Production records by years for various leases in this district show for each lease a year of maximum increased production due to the flood. Taken together the results indicate that the flood boundary has expanded and that the water has moved outward from a central location in the area of the Lewis Leighty lease in the E. 1/2 of sec. 35.

Advance shown by plugging-back records. The approximate positions of the flood water boundary at five-year intervals are indicated by a study of the dates on which the individual wells were plugged back because of the advance of the flood. These data also show an expanding area of water flood with the flow outward from a central area which has the same position as that indicated by the analysis of the production records.

Present fluid levels. Another method of obtaining information as to the direction of advance of the flood is based on the tendency for flow to take place from areas of higher to areas of lower pressures, and consists of (1) determining the height to which oil will rise under equilibrium conditions in wells in various parts of the field, and (2) calculating the true levels referred to a common datum plane. In order that production may not be seriously interrupted, the period for which a well may be left standing before the fluid level is measured is usually not more than 24 hours. In such a case, especially in relatively tight sands, the level may not be a true equilibrium level. Nevertheless the results of the fluid levels study in the McClosky field are of interest; the highest level appears to be in the central part of the elongate flooded district with lower levels near the ends. This also indicates an expansion of the oil-water boundary rather than a contraction such as would be expected in case of edge water encroachment.

Origin of the Flood Water

It is of interest to consider whether the source of the flood may be encroaching edge water in the McClosky sand or whether the water may be introduced into the McClosky sand from some other stratum. In cases of edge water encroachment (a) the oil-water boundary contracts, (b) the production curve shows no

hump, and (c) the hydrostatic pressure at the edge is greater than in the center. In Dennison Township, however, (a) the oil-water boundary has expanded as shown by the plugging-back records, (b) the production for numerous leases has increased markedly after having declined for some years, and (c) the hydrostatic pressure, as shown by measurements of fluid levels, is in general higher in the central part of the elongate flooded area than near its ends. All of the evidence, therefore, points to a source of the flood water outside of the McClosky sand.

Future Extension of Flood

Data on the direction and rate of flood advance indicate that there is a tendency for the boundary to be extended (a) in a northeasterly direction through the J. F. Snyder lease, E. 1/2 NE. 1/4 and NE. 1/4 SE. 1/4, sec. 25, (b) in an easterly direction through the T. F. Leighty lease, W. 1/2 NE. 1/4, sec. 33, and (c) in a northwesterly direction through the Laura and Sherman Gillespie leases, SE. 1/4 sec. 26.

Conclusion

Future benefits in increased production which may result from the flood in areas on which it is now advancing will be limited by the thickness and openness of the sand, by the amount of oil in the sand through which the water is passing, and by the approach of the flood to edge water. Therefore it would seem that no recommendations can be made as to precise locations for new wells. The question of the applicability of deliberate water flooding to Illinois oil fields is dependent on both geologic and economic factors which are to be considered in a later report.